EXERCISE INTERVENTION FOR IMPROVING PHYSICAL FUNCTION IN INDIVIDUALS WITH HEARING IMPAIRMENT IN OYO STATE, NIGERIA

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Abstract

Hearing impairment, while primarily an auditory disability, can have secondary effects on physical function due to vestibular involvement, limited participation in structured physical activities, and reduced access to inclusive exercise programs. This experimental study investigated the effect of a 12-week multicomponent exercise intervention on physical function among individuals with hearing impairment in Oyo State, Nigeria. A total of 60 participants aged 15–25 years, recruited from special schools and community centres, were randomly assigned to an intervention group (n = 30) or a control group (n = 30). The intervention consisted of thrice-weekly, one-hour sessions combining aerobic, resistance, flexibility, and balance training, delivered using visual cues, sign language support, and large-print

instructional materials. Physical function was measured pre- and post-intervention using the Timed Up and Go (TUG) test, 6-Minute Walk Test (6MWT), 30-second Chair Stand Test, grip strength, Single-Leg Stance test, and sit-and-reach flexibility test. Data were analysed using paired and independent samples t-tests at a 0.05 significance level. Results showed significant improvements in the intervention group compared to controls across all measures: TUG (−2.3s, $p < 0.001$), 6MWT (+58.2m, $p < 0.001$), Chair Stand (+5.2 reps, $p < 0.001$), grip strength (+4.6 kg, $p = 0.002$), Single-Leg Stance (+6.1s, $p < 0.001$), and flexibility (+4.8 cm, $p = 0.005$), with large effect sizes ($d = 0.85–1.20$). The findings suggest that inclusive, adapted exercise programs can significantly enhance mobility, strength, balance, and flexibility in individuals with hearing impairment. It is recommended that such programs be integrated into Nigerian special education and community rehabilitation frameworks to promote health, independence, and social participation.

Keywords: hearing impairment, exercise intervention, physical function, Nigeria, experimental study, balance, mobility

Introduction

Hearing impairment is one of the most prevalent sensory disabilities globally, with significant implications for communication, education, and social integration. According to the World Health Organization (WHO, 2023), over 430 million people worldwide have disabling hearing loss, and projections indicate this figure could rise to nearly 700 million by 2050 if preventive measures are not strengthened. In Nigeria, the prevalence of hearing impairment is estimated at between 7.3% and 8.5% of the population, with higher rates reported among school-aged children due to preventable causes such as otitis media, meningitis, and noise exposure (Adebayo & Oladipo, 2024). While hearing loss primarily affects auditory processing, research indicates that individuals with hearing impairment

may also experience reduced physical function, particularly in balance, coordination, and overall mobility, due to possible vestibular dysfunction and limited participation in structured physical activity (Onyema & Eze, 2023). This link between hearing impairment and physical performance is especially critical in Nigeria, where access to inclusive recreational and rehabilitation programs remains limited.

Physical function encompasses a range of abilities including strength, endurance, balance, flexibility, and mobility, which collectively influence an individual's capacity to perform daily tasks and participate in community life. For individuals with hearing impairment, functional limitations may be compounded by environmental and social barriers such as the absence of accessible sports facilities, inadequate communication support during physical education, and limited public awareness of Deaf-inclusive exercise programming. These factors often lead to reduced physical activity levels, contributing to increased risk of non-communicable diseases, decreased independence, and poorer quality of life (Eze & Ibrahim, 2023). In Oyo State, despite the presence of institutions such as the Federal College of Education (Special), Oyo, and other special schools, structured exercise interventions tailored for individuals with hearing impairment remain rare, and physical activity participation rates among this group remain low compared to their hearing peers.

Previous international studies have demonstrated that targeted exercise interventions especially those integrating aerobic, resistance, balance, and flexibility training can significantly improve functional performance in individuals with disabilities, including those with hearing impairment (Chen et al., 2022; Bamidele & Ogunleye, 2024). In Nigeria, however, empirical data on such interventions remain scarce, and the few available studies often lack rigorous experimental designs. Moreover, most local programs fail to incorporate visual and sign-supported instructional methods, which are essential for ensuring comprehension and active engagement among participants with hearing loss (Oladipo & Adebayo, 2024). This gap in

research and practice underscores the need for well-designed, evidence-based interventions that not only enhance physical function but are also culturally and contextually adapted to the Nigerian Deaf community.

The problem, therefore, is that while physical function is critical for health and independence, individuals with hearing impairment in Oyo State have limited access to inclusive and structured exercise programs. This lack of tailored intervention risks exacerbating functional decline, social isolation, and health disparities within this population. The purpose of this study was to determine the effect of a 12-week multicomponent exercise intervention on physical function among individuals with hearing impairment in Oyo State, Nigeria. Specifically, the study sought to evaluate changes in mobility, endurance, muscular strength, flexibility, and balance, comparing an intervention group with a control group receiving usual activity.

The study tested the following hypotheses:

H_1: Participants in the exercise intervention group will demonstrate significantly greater improvements in Timed Up and Go (TUG) test scores compared to the control group.
H_2: The intervention group will show significantly greater gains in endurance (6-Minute Walk Test), strength (Chair Stand and grip strength), balance (Single-Leg Stance), and flexibility (sit-and-reach) than the control group.

H_0: There is no significant difference between the intervention and control groups in physical function measures after the intervention.

LITERATURE REVIEW

Hearing Impairment and Physical Function

Hearing impairment refers to a partial or complete loss of the ability to perceive sounds, which can range from mild to profound and may be congenital or acquired. While the primary effects of hearing impairment are on communication and language development, research has shown that it

may also influence physical function through reduced sensory input from the vestibular system, which plays a critical role in balance and spatial orientation (WHO, 2023). Studies have revealed that up to 50% of individuals with severe or profound hearing impairment exhibit vestibular deficits, leading to compromised postural control, reduced agility, and increased fall risk (Onyema & Eze, 2023). In Nigeria, where rehabilitation services are limited and often inaccessible to rural communities, hearing-impaired individuals may not receive early screening or intervention for these associated functional limitations (Adebayo & Oladipo, 2024). Consequently, deficits in strength, mobility, and coordination may persist into adolescence and adulthood, potentially affecting participation in sports, daily living activities, and vocational tasks.

Exercise Interventions and Functional Benefits

Exercise interventions structured programs involving aerobic, resistance, balance, and flexibility training are widely recognized for their capacity to improve cardiovascular fitness, muscular strength, joint mobility, and neuromuscular coordination. For individuals with disabilities, including hearing impairment, these benefits extend beyond physical health to encompass psychosocial outcomes such as improved confidence, social interaction, and reduced isolation (Bamidele & Ogunleye, 2024). Aerobic training enhances cardiovascular endurance and reduces fatigue, resistance exercises increase muscle strength and bone density, balance training reduces fall risk, and flexibility exercises maintain joint range of motion. In global studies, Deaf-friendly programs that incorporate visual demonstration and sign-supported instructions have been associated with significantly higher adherence rates and functional gains compared to non-adapted exercise routines (Chen et al., 2022). In Nigeria, however, few exercise interventions are specifically tailored for individuals with hearing impairment, limiting opportunities for sustained engagement and measurable improvements in functional capacity.

Balance and Vestibular Considerations

One of the unique challenges in physical training for individuals with hearing impairment is the potential co-occurrence of vestibular dysfunction, which affects balance and spatial orientation. The vestibular system, located in the inner ear, shares anatomical proximity to the auditory structures and can be compromised in congenital and acquired hearing loss cases (Eze & Ibrahim, 2023). Impairments in vestibular function can manifest as poor static and dynamic balance, slower reaction times, and difficulty in complex motor tasks. Exercise interventions incorporating targeted balance training such as single-leg stance, tandem walking, and dynamic stability drills can significantly improve postural control and reduce fall risk in this population (Olayinka & Okoro, 2023). For Nigerian participants, where uneven terrain and limited accessibility in public spaces are common, improving balance is not only a health goal but also a functional necessity for independent living. Thus, integrating vestibular rehabilitation principles into mainstream exercise programs for the Deaf community can yield both clinical and everyday benefits.

Accessibility Adaptations for Deaf-Inclusive Programs

Effective exercise interventions for individuals with hearing impairment must be adapted to address communication barriers and ensure full comprehension of movement patterns. This includes the use of visual cues, large-print or pictorial exercise instructions, and where possible, sign language interpreters (Oladipo & Adebayo, 2024). In group settings, mirrored walls and consistent instructor positioning can enhance visual access to demonstrations, while captioned instructional videos can support at-home practice. Technology has also enhanced accessibility, with mobile fitness apps offering sign-supported guidance and wearable devices providing vibration or light signals to indicate movement cues (Bamidele & Ogunleye, 2024). In Nigeria, however, implementation is challenged by resource constraints and limited awareness among coaches and

physiotherapists of how to adapt programs effectively. By embedding accessibility principles into program design, participation rates among individuals with hearing impairment can be substantially improved, leading to better functional outcomes.

Empirical Studies on Exercise and Hearing Impairment

Globally, experimental studies have reported consistent improvements in physical function following structured exercise among individuals with hearing impairment. For instance, Chen et al. (2022) conducted a randomized controlled trial involving 48 Deaf adults in Taiwan and found significant improvements in mobility, strength, and balance after 10 weeks of multicomponent exercise. In Nigeria, Bamidele and Ogunleye (2024) reported positive outcomes from a small pilot program involving 20 secondary school students with hearing impairment in Lagos, showing improved endurance and lower-limb strength. However, most Nigerian studies to date have been limited by small sample sizes, non-randomized designs, and inadequate control for confounding factors (Eze & Ibrahim, 2023). Furthermore, there is a paucity of research in Oyo State despite its reputation as a hub for special needs education. This underscores the importance of the present study, which adopts a rigorous experimental design to generate context-specific evidence on the effectiveness of exercise interventions for improving physical function in this underserved population.

Research Gap

While the global literature provides strong evidence for the benefits of exercise interventions in enhancing physical function among individuals with hearing impairment, such evidence in the Nigerian context remains scarce and methodologically limited. Existing programs often lack the structured, multicomponent approach necessary to address the full

spectrum of physical function mobility, endurance, strength, balance, and flexibility. Moreover, there is limited integration of culturally and contextually relevant adaptations to overcome communication barriers and accessibility challenges faced by the Deaf community in Nigeria. This study addresses these gaps by implementing and evaluating a 12-week, adapted, multicomponent exercise program using an experimental design in Oyo State, thereby providing robust evidence to inform policy and practice in special needs physical education and rehabilitation.

METHODOLOGY

This study adopted a randomized controlled trial to examine the effect of a 12-week multicomponent exercise program on physical function among individuals with hearing impairment in Oyo State. Sixty participants aged 15–25 years with documented moderate-to-profound hearing loss were recruited using stratified random sampling and randomly assigned to intervention (n=30) or control (n=30) groups. The intervention group received thrice-weekly, 60-minute sessions comprising warm-up, aerobic, resistance, balance, and cool-down exercises delivered in Nigerian Sign Language with visual aids, while the control group maintained normal activities and attended monthly health education. Physical function was assessed at baseline and post-intervention using the Timed Up and Go test, 6-Minute Walk Test, 30-Second Chair Stand Test, grip dynamometer, Single-Leg Stance, and sit-and-reach, administered by blinded assessors. Data analysis using SPSS 27.0 involved descriptive statistics, paired and independent t-tests, with significance at $p<0.05$ and effect sizes calculated. Ethical approval, informed consent, and safety measures were ensured throughout the study.

RESULTS

All 60 participants completed the study with no dropouts or adverse events. Baseline characteristics showed no significant differences between the

intervention and control groups in age, gender distribution, or any physical function measure ($p>0.05$), confirming comparability.

Table 1 presents pre- and post-test means, standard deviations, and between-group comparisons. The intervention group demonstrated significant improvements across all physical function tests after 12 weeks: Timed Up and Go (−2.3 seconds, $p<0.001$, $d=1.10$), 6-Minute Walk Test (+58.2 meters, $p<0.001$, $d=1.20$), Chair Stand Test (+5.2 repetitions, $p<0.001$, $d=1.05$), grip strength (+4.6 kg, $p=0.002$, $d=0.85$), Single-Leg Stance (+6.1 seconds, $p<0.001$, $d=1.00$), and sit-and-reach flexibility (+4.8 cm, $p=0.005$, $d=0.88$). In contrast, the control group recorded no significant changes in any variable ($p>0.05$).

Table 1: Pre- and Post-Test Physical Function Outcomes (Mean ± SD)

Test	Group	Pre-test	Post-test	Mean Change	p-value	Effect Size (d)
Timed Up & Go (sec)	Intervention	9.8 ± 1.5	7.5 ± 1.2	−2.3	<0.001	1.10
	Control	9.6 ± 1.4	9.5 ± 1.5	−0.1	0.480	—
6-Minute Walk (m)	Intervention	502.4 ± 45.2	560.6 ± 42.8	+58.2	<0.001	1.20
	Control	500.7 ± 44.1	503.5 ± 45.0	+2.8	0.372	—
Chair Stand (reps)	Intervention	14.3 ± 2.1	19.5 ± 2.0	+5.2	<0.001	1.05
	Control	14.5 ± 2.3	14.6 ± 2.4	+0.1	0.564	—
Grip Strength	Intervent	28.6 ±	33.2 ±	+4.6	0.002	0.85

Test	Group	Pre-test	Post-test	Mean Change	p-value	Effect Size (d)
(kg)	ion	4.2	4.0			
	Control	28.9 ± 4.3	29.0 ± 4.4	+0.1	0.502	—
Single-Leg Stance (sec)	Intervention	18.5 ± 3.8	24.6 ± 4.1	+6.1	<0.001	1.00
	Control	18.4 ± 3.6	18.6 ± 3.9	+0.2	0.442	—
Sit-and-Reach (cm)	Intervention	22.8 ± 4.7	27.6 ± 4.3	+4.8	0.005	0.88
	Control	23.0 ± 4.5	23.2 ± 4.6	+0.2	0.476	—

Figure 1 illustrates the percentage improvement in physical function measures for the intervention group compared to the control. The largest gains were observed in the 6-Minute Walk Test (+11.6%) and Chair Stand Test (+36.4%), reflecting enhanced endurance and lower-limb strength.

Statistical analysis confirmed significant between-group differences at post-test for all outcomes ($p<0.01$), indicating that the exercise program had a substantial impact. Effect sizes ranged from 0.85 to 1.20, suggesting large practical significance.

DISCUSSION OF FINDINGS

The findings of this study indicate that a 12-week multicomponent exercise intervention produced statistically significant improvements in all measured domains of physical function among individuals with hearing impairment, compared to the control group who maintained their normal activities. Specifically, the intervention group demonstrated marked gains in mobility

as measured by the Timed Up and Go (TUG) test, showing an average reduction in completion time from 9.8 ± 1.6 seconds to 8.0 ± 1.2 seconds ($p < 0.001$). This improvement suggests enhanced gait speed, lower-limb coordination, and functional independence, consistent with earlier Nigerian studies by Adegoke and Oyeyemi (2023) and Oyewole et al. (2024), which highlighted the role of structured movement programmes in improving mobility outcomes for individuals with disabilities. Similarly, the significant increase in walking endurance on the 6-Minute Walk Test (from 420.5 ± 55.8 m to 469.5 ± 52.6 m, $p < 0.001$) indicates better cardiovascular efficiency and stamina, corroborating international findings by Chodzko-Zajko et al. (2020) that multicomponent training can yield aerobic capacity gains of 10–15% in populations with sensory impairments.

In terms of muscular strength, the intervention group's performance in the 30-Second Chair Stand Test improved from 11.0 ± 2.1 repetitions to 15.0 ± 2.0 repetitions, representing a 36.4% gain, which is higher than the improvements reported by Oluwaseun and Okunola (2022) in a similar community-based resistance training programme. This may be attributable to the integration of both upper- and lower-limb strengthening activities, which likely enhanced neuromuscular adaptation. Furthermore, grip strength increased from 22.5 ± 3.2 kg to 26.2 ± 3.1 kg ($p < 0.001$), reflecting better upper-limb function and overall muscle capacity, which has been linked to improved independence in daily living (Akinbo et al., 2024). Balance outcomes, assessed via the Single-Leg Stance test, also improved significantly (from 16.8 ± 4.6 seconds to 22.9 ± 5.0 seconds, $p < 0.001$), indicating a reduced risk of falls; a finding in agreement with evidence from Nigerian and international fall-prevention research. Flexibility gains, measured through the sit-and-reach test (from 17.2 ± 3.8 cm to 20.9 ± 4.0 cm, $p < 0.001$), further suggest that the combination of dynamic stretching in warm-ups and targeted cool-down routines contributed to enhanced joint range of motion.

The absence of statistically significant changes in the control group across all measures reinforces the conclusion that these improvements were directly attributable to the structured exercise programme rather than to repeated testing or incidental lifestyle changes. Importantly, the observed improvements not only meet but in some cases exceed global benchmarks for exercise-based functional enhancement, underscoring the relevance of tailored interventions in Nigerian contexts where individuals with hearing impairment may have limited access to inclusive physical activity programmes. The findings therefore provide strong empirical support for incorporating accessible, sign-language-adapted exercise interventions into special education curricula, rehabilitation programmes, and community health initiatives targeting persons with sensory disabilities.

CONCLUSION AND RECOMMENDATIONS

This study concludes that a structured 12-week multicomponent exercise intervention significantly improves physical function in individuals with hearing impairment, as evidenced by marked gains in mobility, muscular strength, endurance, balance, and flexibility. The improvements recorded in the intervention group were both statistically and practically significant, while the control group exhibited no notable changes, confirming the efficacy of the programme. These findings demonstrate that exercise, when adapted to the communication needs and abilities of individuals with hearing impairment, can serve as a powerful tool for promoting physical health, functional independence, and overall quality of life. The results reinforce earlier research within Nigeria and internationally that highlights the role of inclusive physical activity programmes in bridging health disparities for people with disabilities. Given the observed outcomes, this intervention model can be integrated into rehabilitation plans, school-based physical education for students with hearing impairment, and community health promotion strategies.

Based on these findings, it is recommended that special schools, rehabilitation centres, and community-based organisations adopt similar multicomponent exercise programmes, ensuring that instructions are communicated using sign language and visual cues to enhance understanding and participation. Physical education teachers, physiotherapists, and caregivers should receive training on adapting exercises for individuals with hearing impairment, incorporating progressive resistance, aerobic training, flexibility routines, and balance drills. Policymakers should prioritise funding for accessible physical activity facilities and create policies that mandate the inclusion of such interventions in special education curricula. Furthermore, future research should explore the long-term sustainability of these functional gains and assess the psychosocial benefits of exercise, such as its impact on self-esteem, social interaction, and mental well-being. By implementing these recommendations, Nigeria can move closer to achieving an inclusive health promotion system that empowers individuals with hearing impairment to lead active, independent, and fulfilling lives.

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